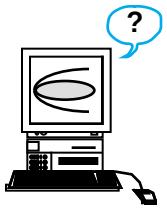


Ask Dr. ALOHA:

Working with toxic and odor thresholds

At the Port of Lakeside City, on the shore of Lake Superior, Emergency Manager Jim Holland has just received a radio message from the captain of an inbound barge. A portable tank on the barge deck is slowly leaking ethyl mercaptan. Crew members have observed a small pool of this liquid forming on deck. While the barge is underway, the crew can't stop the leak—it seems to be coming from a leaking valve next to a bulkhead, where they can't reach it. Within a few hours, the barge is scheduled to arrive at Lakeside City.

Because ethyl mercaptan is strong-smelling, it is commonly used as an additive to natural gas, which is odorless, so that people can detect gas leaks. At high concentrations, though, its vapor is toxic, damaging the central nervous systems of people who inhale its vapors. Therefore, Jim's first order of business is to determine the level of toxic hazard that the barge, once in port, could pose to the city. To get an estimate, he turns to ALOHA.

To use ALOHA, he first must choose a level of concern (LOC)—the concentration of ethyl mercaptan gas in air that represents the hazard of concern. Because Jim is concerned about the toxic effects of ethyl mercaptan, he needs to choose a toxic threshold.

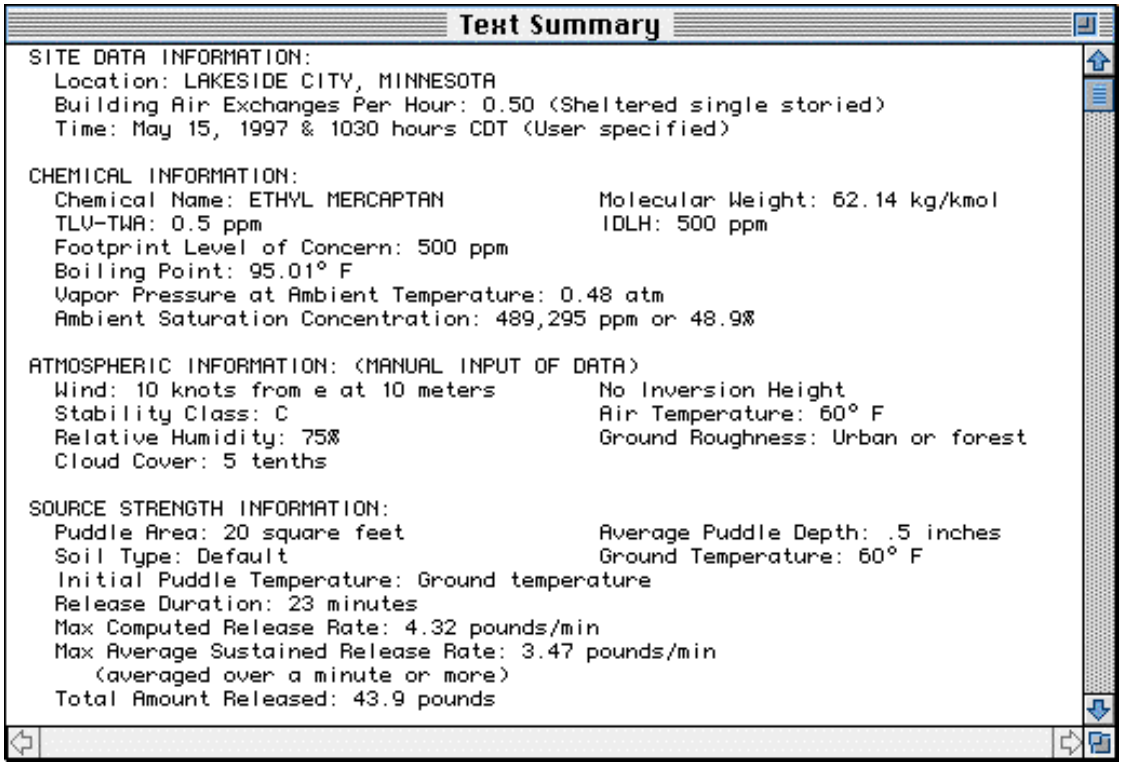
ALOHA's chemical library contains one common toxic threshold, the IDLH (Immediately Dangerous to Life and Health), which represents the maximum concentration of a chemical in the air to which a healthy adult worker could be exposed for 30 minutes without suffering permanent or escape-impairing health effects. However, Jim decides to use a more conservative toxic threshold, called the PEL (Permissable Exposure Limit), developed by the Occupational Safety and Health Administration (OSHA). (A value is "conservative" if by using it, you are more likely to overestimate the footprint than to underestimate it.) The PEL of 10 ppm that has been established for ethyl mercaptan represents a concentration threshold that should not be exceeded at any time in a workplace populated by healthy adult workers.

Jim recognizes that a drawback of both the PEL and IDLH thresholds is that both are workplace limits representing thresholds for healthy adult workers. However, Jim needs to assess the toxic hazard not just to healthy adults, but to a typical city population, which also includes elderly people, children, sick people, and pregnant women, all likely to be especially susceptible to a toxic chemical. But until toxicologists collect more information about the toxic effects of ethyl mercaptan, Jim has no better alternative.

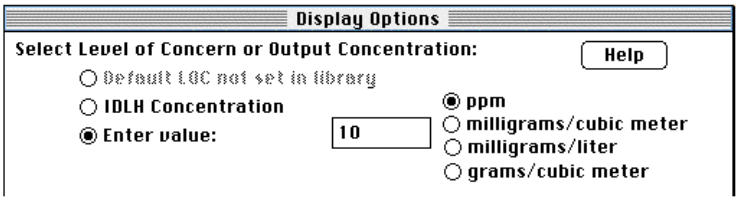
Jim starts ALOHA and begins to enter information about the spill scenario. To assess the hazard to Lakeside City, he assumes that the barge, still leaking ethyl mercaptan, has docked at the port, which is adjacent to the main business district. He calls the National Weather Service to obtain information about the expected weather conditions at the freighter's estimated arrival time. He is especially concerned to hear that the prevailing wind would blow the ethyl mercaptan vapors from the dock directly into the city. He enters these weather conditions into ALOHA.

The barge captain had told him that crew members have observed a small pool of ethyl mercaptan liquid on the ship's deck. They estimated the pool to be shallow and about 20 square feet in area. From ALOHA's **SetUp** menu, Jim chooses the **Puddle...** source option, and enters information about the puddle, guesstimating that it's about half an inch deep and at ambient temperature (he'll revise these entries and run ALOHA again if more information about the puddle becomes available).

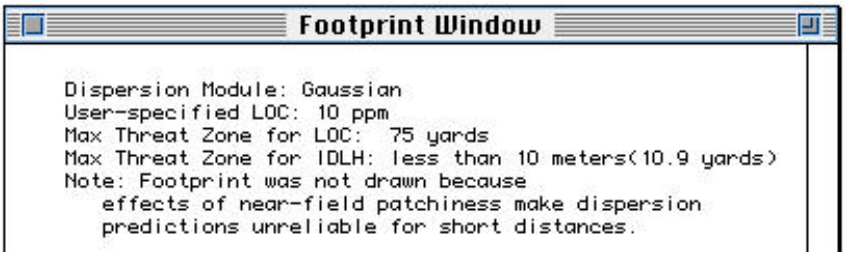
When Jim has finished entering information about the scenario, his Text Summary screen looks like the one below.



Next, Jim needs to enter the LOC he has selected. From the **Display** menu, Jim chooses **Options...,** then types in the PEL value of 10 ppm (see below), and clicks **OK**.



Jim is now ready to get a footprint. From the **Display** menu, he chooses **Footprint**. He is relieved to see that ALOHA predicts that ethyl mercaptan concentrations would not exceed the PEL for more than 75 yards downwind of the puddle (see below). These results indicate that ethyl mercaptan's toxic vapors would be a serious concern mainly for people working in the general area of the barge. However, Jim knows that ALOHA's footprint is only a ballpark estimate of the real area where concentrations may reach toxic levels. He will be alert to any new information about weather conditions or the circumstances of the spill and ready to run ALOHA with new information if necessary.



Estimating the "Phone Call Zone"

Jim has not finished his work with ALOHA. He knows that ethyl mercaptan has a very strong and unpleasant odor. He also knows that during previous incidents, people have become very concerned when they smelled a spilled chemical. Jim would like to estimate the area where people may smell ethyl mercaptan vapors. Within this area, people may call emergency services for information or report to local hospitals; he wants to account for this possibility in his incident planning.

Ethyl mercaptan has a very low **odor threshold**. A chemical's odor threshold is the lowest concentration of that chemical in air that people can smell. Odor thresholds are imprecise measurements, because people naturally vary widely in their sensitivity to odors, and illness and other impairments can make people less sensitive to odor than they would otherwise be. For these reasons, our sense of smell is a very unreliable detector of the presence of hazardous gases. There are other reasons to avoid relying on your nose to detect a toxic gas: some chemicals, such as hydrazine, are toxic at concentrations lower than their odor thresholds—these gases would reach toxic levels before you could smell them—some, such as carbon monoxide, have no odor at all; and others, such as hydrogen sulfide, can "deaden" the sense of smell when they are present at high concentrations.

Still, there is at least one use for odor thresholds in emergency response. The area where chemical concentrations may exceed the odor threshold can serve as a crude estimate of the **phone call zone**: the area where people may become anxious because they detect a chemical, even when chemical concentrations are well below toxic levels. When you know the extent of this area, you might wish to alert emergency and medical personnel within the phone call zone to plan for potentially high levels of public anxiety.

To estimate the phone call zone, Jim will use ethyl mercaptan's estimated odor threshold as his LOC in ALOHA. When he does this, ALOHA's footprint will represent the phone call zone. He checks a list published in 1989 by the American Industrial Hygiene Association, and finds an estimate of 0.0035 ppm as the approximate odor threshold of ethyl mercaptan. Actually, since odor thresholds are so imprecise, researchers normally report them as ranges rather than exact numbers (check Table 1, below, to see that these ranges can be very wide for some chemicals). The value 0.0035 ppm is the geometric mean of a range of estimates—it represents a sort of best guess of the odor threshold of ethyl mercaptan.

To use this odor threshold estimate in ALOHA, from the **Display** menu, Jim chooses **Options...,** then types in the estimate of 0.0035 ppm, and clicks **OK**. Next, from the **Display** menu, he chooses **Footprint**. He sees that ALOHA predicts that the phone call zone will extend for nearly 6 miles downwind, as the footprint below shows. As Jim plans the response to this incident, he can now account for the widespread public concern that may develop in this general area. Again, he bears in mind the fact that this footprint is just a ballpark estimate of the real area where people may detect ethyl mercaptan. People with especially sensitive noses may detect ethyl mercaptan's odor at distances farther from the barge than the footprint indicates. Others with poorer senses of smell may not detect the odor even if they are well within the area covered by the footprint. Still, Jim is glad to have at least a general idea of the extent of the area where emergency and medical services may be called on most heavily.

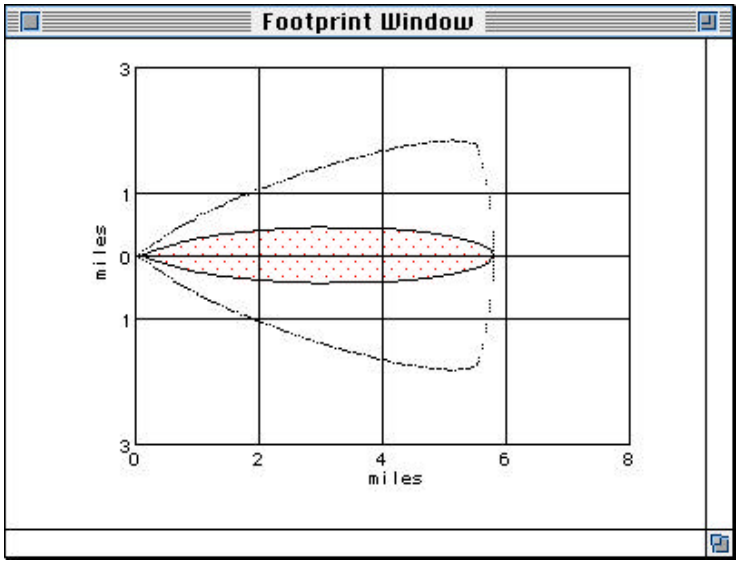


Table 1. Odor thresholds and TLVs (Threshold Limit Values) of some ALOHA chemicals. Values in the "CHRIS" column were obtained from the CHRIS manual, values in the "AAR" column are from the American Association of Railroads, and values in the "AIHA" column are from the American Industrial Hygiene Association.

Compound	**Odor Threshold (ppm)**			**TLV (ppm)**
	CHRIS	**AAR**	**AIHA**	
Acetaldehyde	0.21	0.01-0.031	0.0028-1000	25
Acetone	100	0.66-320	0.0370.15	750
Ammonia (anhydrous)	47	0.037-20	0.043-53	25
Benzene	4.7	0.16-320	0.78-160	10
Carbon monoxide	odorless	odorless	odorless	25
Carbon tetrachloride	>10	15-50	1.6-706	5
Chlorine	3.5	0.02-3.5	0.021-3.4	0.5
Cumene	1.2	-	0.0051-1.3	50
Cyclohexane	-	0.41	0.52-784	300
dicyclopentadiene	0.003	0.02	0.003-0.011	5
Ethyl benzene	140	0.25-2.3	0.092-0.60	100
n-Hexane	-	-	65-248	50
Hydrogen sulfide	0.0047	0.13	0.00007-1.4	10
Methyl ethyl ketone	10	11-27	0.25-85	200
Naphthalene	N/A	0.3-0.9	0.0095-0.64	10
Phenol	0.05	-	0.0045-1	5
Phosgene	0.5	0.125-1	0.12-5.7	0.1
Phosphine	0.14	0.02	0.01-5	0.3
Styrene monomer	0.148	0.02-0.47	0.0047-61	50
Sulfur dioxide	3	3	0.33-5	2
Toluene	0.17	0.17-40	0.021-69	50
Vinyl chloride	260	260-25,000	-	5
o,m,p-Xylene	0.05	0.2-4	0.081-5.4	100

References

American Industrial Hygiene Association. 1989. Odor thresholds for chemicals with established occupational health standards. Akron, OH: AIHA.

National Institute for Occupational Health and Safety (NIOSH), U. S. Department of Health and Human Services (DHHS). 1990. NIOSH Pocket Guide to Chemical Hazards. DHHS (NIOSH) Publication No. 90-117. U. S. Government Printing Office. Washington, D. C. Available from Publications Dissemination, DSDTT, NIOSH, 4676 Columbia Parkway, Cincinnati, OH, 45226 (513/533-8287). *Lists TLVs , permissible exposure limits (PELs), and immediately dangerous to life and health (IDLH) values, as well as general industrial hygiene information for 398 chemical substances.*

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